AMENDMENTS TO THE SPECIFICATION

Please amend the paragraph(s) from page 2, line 3 from the bottom to page 3, last line as follows:

An antenna device of the present invention ~~comprising~~comprises a resonance element array having a plurality of resonance elements arranged therein, and having a circuit connected to each of the resonance elements~~, the circuit provided therein, and the circuit~~ for controlling a resonance frequency of the resonance elements; a primary radiator for radiating an electromagnetic wave for excitation to the resonance element array or for receiving an electromagnetic wave radiated from the resonance elements; and collimating means of a lens or reflector disposed such that the position of the resonance element array is a focus plane literally or any position regarded substantially as the focus plane.

~~An~~Another antenna device of the present invention ~~comprising~~comprises a resonance element array having a plurality of resonance elements resonating at a fixed (predetermined) frequency arranged therein, and having variable reactance circuits connected to the resonance elements, respectively, ~~whose~~each reactance of which is changed by an applied voltage~~, the circuits provided therein~~; a control portion for controlling a voltage to be applied to the variable reactance circuits; a primary radiator for radiating an electromagnetic wave for excitation to the resonance element array or for receiving an electromagnetic wave radiated from the resonance elements; and collimating means of a lens or reflector disposed such that the position of the resonance element array is a focus plane literally or any position regarded substantially as the focus plane.

In this way, the directivity of an antenna can be electronically controlled with high freedom ~~such that~~as an arbitrary or desired resonance element out of a plurality of resonance elements existing substantially on the focus plane of collimating means of a lens

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or reflector ~~are~~is excited. Furthermore, when required, a radiation pattern of beams can be changed ~~such that~~as ~~a plurality of arbitrary~~some resonance elements out of a plurality of resonance elements are simultaneously excited.

Please amend the paragraph(s) from page 4, line 7 from the bottom to page 8, line 5 as follows:

Accordingly, it is possible to electronically control the ~~directivity~~ beam direction by controlling an applied voltage to the variable reactance circuits.

Furthermore, in an antenna device of the present invention, ~~the primary radiator contains~~ a plurality of primary radiators may be provided so that the radiation position to the resonance element array may be optimized or the position for receiving an electromagnetic wave radiated from the resonance element array may be optimized. Thus, even if the plurality of resonance elements contained in a resonance element array is widely distributed, resonance elements to be excited can be excited by using a primary radiator situated close to the resonance elements. Furthermore, an electromagnetic wave radiated from fixed resonance elements can be received by the primary radiator close to the resonance elements.

Furthermore, in an antenna device of the present invention, the primary radiator ~~contains~~may include an opening hollow resonator and an excitation source for exciting the opening hollow resonator. Thus, the spatial coupling between each resonance element of a resonance element array and an excitation source is easily performed such that only the resonance element array is disposed at the opening portion of the hollow resonator.

Furthermore, in an antenna device of the present invention, the plurality of resonance elements ~~are~~may include linear conductors ~~which are~~extending substantially perpendicular to the arrangement direction and ~~extend~~ parallel to each other. Thus, the resonance element array can be easily constituted on a dielectric substrate.

Furthermore, in an antenna device of the present invention, the plurality of resonance elements ~~are~~may include linear conductors ~~which are~~extending substantially 45 degrees tilted to the arrangement direction and ~~extend~~ parallel to each other. Thus, when an electromagnetic wave transmitted by another antenna device constituted in the same way is received from the direction of the front, since the plane of polarization is perpendicular to the plane of polarization of the own antenna device, the affect of crossing polarized waves can be reduced.

Furthermore, in an antenna device of the present invention, a variable capacitance diode changing the load reactance to the resonance element ~~is~~may be ~~contained~~included in the variable reactance circuit, and the control portion applies a reverse bias voltage to the variable capacitance diode.

Furthermore, in an antenna device of the present invention, a switching element for switching the load reactance to the resonance element ~~is~~may be included ~~contained~~ in the variable reactance circuit, and the control portion applies a control voltage to the switching element.

Furthermore, in an antenna device of the present invention, an MEMS element where the distance between electrodes is changed by a control voltage ~~is~~may be included ~~contained~~ in the variable reactance circuit, and the control portion applies a control voltage to the MEMS element.

Furthermore, in an antenna device of the present invention, the switching element ~~is~~may be an MEMS element where a switching control between electrodes is performed by a control voltage.

Furthermore, in an antenna device of the present invention, the primary radiator ~~is~~may be an electronically controlled wave director array antenna in which a feed element is disposed in the center and non-feed elements having a reactance loaded therein are disposed around the feed element. Thus, the radiation pattern of an electromagnetic wave formed in the direction of a resonance element array becomes controllable.

Furthermore, a radio device of the present invention ~~contains~~may include one of the above antenna devices.

Moreover, a radar of the present invention ~~contains~~may include one of the above antenna devices.

As described above, according to the present invention, the directivity of an antenna can be electronically controlled with high freedom ~~such that~~as an arbitrary or desired resonance element out of a plurality of resonance elements existing substantially on the focus plane of collimating means of a lens or reflector ~~are~~is excited. Furthermore, when required, a radiation pattern of beams can be changed ~~such that~~ ~~a plurality of~~ ~~arbitrary~~as some desired resonance elements out of a plurality of resonance elements are simultaneously excited.

Furthermore, according to the present invention, by controlling an applied voltage to the variable reactance circuits, ~~since~~a resonance elements at a fixed positions operating as a wave director out of the plurality of resonance elements ~~are changed to~~is replaced with another resonance elements at another positions, the ~~directivity~~ direction of a

beam can be electronically controlled and, as required, the beam can be directed to a desired direction and the beam direction can be randomly scanned.

Furthermore, according to the present invention, since ~~the primary radiator contains~~ a plurality of primary radiators is provided so that the radiation position to the resonance element array may be optimized or the position for receiving an electromagnetic wave radiated from the resonance element array may be optimized, even if the plurality of resonance elements in the resonance element array is widely distributed, resonance elements can be excited by using a primary resonator close to the resonance elements to be excited. Furthermore, since an electromagnetic wave radiated from fixed resonance elements can be received by a primary radiator close to the fixed resonance elements, uniform sensitivities can be realized over a wide range.

Please amend the paragraph(s) from page 8, line 13 to page 8, line 2 from the bottom as follows:

Furthermore, according to the present invention, since the plurality of resonance elements ~~are~~includes linear conductors ~~which are~~extending substantially perpendicular to their arrangement direction and ~~extend~~ parallel to each other, the resonance element array can be easily constituted on a dielectric substrate.

Furthermore, according to the present invention, since the plurality of resonance elements ~~are~~includes linear conductors ~~which are~~extending substantially 45 degrees tilted to their arrangement direction and ~~extend~~ parallel to each other, when a radio wave transmitted from another antenna device of the same structure from the direction of the

front, its plane of polarization is at a right angle to the plane of polarization of the own antenna device and the affect of the crossing planes of polarization can be reduced.

Please amend the paragraph(s) from page 9, line 6 to page 912, line as follows:

Furthermore, according to the present invention, since a switching element for switching the load reactance to the resonance element is contained in the variable reactance circuit, and the control portion applies a control voltage to the switching element, the switching between a resonant ~~and~~or a non-resonant state~~s~~ of the resonance element, or between the state of a wave director ~~and~~or the state of a reflector can be easily performed.

Please amend the paragraph(s) from page 10, line 7 from the bottom to page 7, line 4 from the bottom as follows:

Figs. 1A and 1B ~~shows~~ show the whole structure of an antenna device according to a first embodiment.

Figs. 2A and 2B ~~shows~~ show the structure of a resonance element array, resonance elements, and variable reactance circuits.

Please amend the paragraph(s) from page 11, line 2 to line 3 as follows:

Figs. 5A and 5B ~~shows~~ show the structure of a variable reactance circuit of an antenna device according to a second embodiment.

Please amend the paragraph(s) from page 12, line 1 to page 13, line 6 from the bottom as follows:

Fig. 1 shows the whole structure of the antenna device. Here, reference numeral 1 represents a primary radiator in a horn antenna and reference numeral 200 represents a resonance element array. In this resonance element array 200, a plurality of resonance elements ~~are~~is provided in a array as will be described later. When this antenna device is used as a transmission antenna, the primary radiator 1 radiates an electromagnetic wave for excitation toward resonance element array 200.

The primary radiator 1 radiates an electromagnetic wave of a linearly polarized wave in the TE10 mode, for example. Part (B) in Fig. 1 shows the radiation pattern of the primary radiator 1. In this way, although the primary radiator 1 has the directivity in the direction of the resonance element array 200, it gives a substantially uniform electric power to the plurality of resonance elements provided in the resonance element array 200.

Out of the plurality of resonance elements provided in the resonance element array 200, a fixed resonance elements ~~are~~is resonant with the frequency of the electromagnetic wave radiated from the primary radiator 1 and function as a wave director.

In part (A) of Fig. 1, reference numeral 3 represents a lens made of a dielectric material and having the resonance element array 200 ~~as~~in a focal plane or any position regarded substantially as the focal plane. Since the plurality of resonance elements in the resonance element array 200 is in the focal plane of the lens 3 or in any position regarded substantially as the focal plane, the direction of a beam is determined in accordance with the position of the resonance elements in resonance (that is, which function as a wave director) out of the plurality of resonance elements.

Fig. 2 shows the structure and function of the above resonance element array. Part (A) of Fig. 2 is a top view when the resonance element array 200 is viewed from the side of the lens 3. In the resonance element array 200, the plurality of resonance elements

201, each of which is made of a linear conductor, formed on one surface of a dielectric substrate 203 are arranged so as to be parallel to each other. These linear conductors are disposed so as to be parallel to the direction of a polarized wave in the TE10 mode radiated from the primary radiator.

Furthermore, a variable reactance circuit 202 is provided substantially in the middle of a resonance element 201. A control portion 4 selectively gives a control voltage to each variable reactance circuit 202 of the resonance elements 201a to 201k through a control signal line 9. For example, when the resonance element 201f is made completely resonant or substantially resonant at a frequency in use and the other resonance elements 201a to 201e and 201g to 201k are made non-resonant, the resonance element 201f functions as a wave director. In the same way, for example, when the resonance element 201d is made completely resonant or substantially resonant and the remaining resonance elements 201a to 201c and 201e to 201 k are made non-resonant, the resonance element 201d functions as a wave director.

Please amend the paragraph(s) from page 14, line 1 to page 14, line 8 from the bottom as follows:

Moreover, a resonance element may be made to operate as a reflector at a frequency in use such that the resonance frequency of the resonance element which is made non-resonant at the frequency in use is set to be a fixed ratio lower ~~then~~than the frequency in use.

Part (B) of Fig. 2 shows that the resonance element 201d operates as a wave director. Thus, an electromagnetic wave is re-radiated from the resonance element 201d excited by the primary radiator 1 and is collimated by the lens 3 shown in Fig. 1.

Fig. 3 shows examples where the direction of a beam changes in accordance with the position of a resonance element operating as a wave director out of the plurality of resonance elements provided in the resonance element array 200. In these examples, when the resonance element 201f is excited by an electromagnetic wave from the primary radiator and operates as a wave director, the beams in the directions shown by optical paths 5f, that is, in the direction of the front are formed. Furthermore, when the resonance element 201d is excited by an electromagnetic wave from the primary radiator and operates as a wave director, the beams in the direction of optical paths 5d, that is, in the direction θ tilted from the direction ~~to~~of the front face are formed.

Please amend the paragraph(s) from page 14, line 3 from the bottom to page 15, line 8 from the bottom as follows:

Furthermore, the number of resonance elements which are made to operate as a wave director is not limited to be single; out of the arranged plurality of resonance elements, two or more consecutive resonance elements are made to operate as ~~a~~ wave directors, and the remaining resonance elements may be made to operate as ~~a~~ reflectors. In this way, the width of a radiation pattern of beams can be widened.

Furthermore, when a plurality of resonance elements ~~are~~is made to operate as a wave director, not resonance elements at consecutive positions, but, when necessary,

resonance elements positioned at intervals may be made as ~~a~~ wave directors. In this way, a radiation pattern of beams which have been collimated may be changed in various ways.

Fig. 4 shows a more concrete example of the variable reactance circuit portion shown in part (A) of Fig. 2. In this example, the variable reactance circuit 202 is constituted such that two sets of circuits each of which is made up of a variable diode ~~Dr~~Dv, a resistor R, and a capacitor C are symmetrically provided, and such that the cathode side of each of the two varactor diodes Dv is connected to the end portions of the resonance element 201, respectively, and the anode side is grounded. Here, the resistor R and the capacitor C constitute a filter which prevents high-frequency signals from leaking to the control portion 4.

Please amend the paragraph(s) from page 16, line 15 to page 16, line 6 as follows:

Moreover, in the example shown in Fig. 4, although a varactor diode is used in the variable reactance circuit, ~~the electrode-to-electrode distance is controlled such that~~ an MEMS (microelectromechanical system) element ~~is~~may be used and the drive voltage is applied such that the electrode-to electrode distance is controlled, and as a result, the reactance may be changed.

As is described above, although a primary radiator having ~~only~~ a relatively low gain is used, the position of resonance elements operating as a wave director is electronically determined in a resonance element array, and a high gain beam is formed and the radiation direction can be changed ~~such that~~as an electromagnetic wave radiated from the resonance element is collimated by using a lens having a focus plane at the position of a

resonance element array. Accordingly, the antenna device can be managed with one system of a high-frequency circuit portion, different from the phased array antenna constituted as a related electronically controlled antenna. That is, since basically only a single primary radiator is used, a low-cost and small antenna device of lower power consumption can be utilized when compared with the phased array antenna.

Please amend the paragraph(s) from page 17, line 10 to line 17 as follows:

Next, the structure of an antenna device according to a second embodiment is shown in Fig. 5. Different from the antenna device of the first embodiment shown in Fig. 4, in this example, switching circuits 204, switching the load capacitance to the resonance element 201 in two ways by application of a control voltage, are provided in the variable reactance circuit 202. Part (A) of Fig. 5 shows its schematic diagram and part (B) is its concrete circuit diagram.

Please amend the paragraph(s) from page 18, line 9 to page 22, line 7 from the bottom as follows:

When the reactance circuit 202 is constituted in this way, it is easy to make one fixed resonance element or some fixed resonance elements operate as a wave director or wave directors and make the remaining resonance elements as a reflector by simply switching the control voltage.

In the example shown in Fig. 5, although the diode D1 is used as a switching element, ~~the connection between the electrodes may be on-off controlled such that~~ an

MEMS (microelectromechanical system) switch element ~~is~~may be used~~. and the drive voltage is applied.~~ By applying a drive voltage to the MEMS switch element, a connection between the electrode of the MEMS switch element may be on-off controlled.

Next, the structure of an antenna device according to a third embodiment is shown in Fig. 6. Different from the antenna device of the first embodiment shown in Fig. 1, in this example, three primary radiators 1a, 1b, and 1c are ~~contained as the primary radiator~~provided. This is to solve a problem in that, since a plurality of resonance elements in the resonance element array is provided in a relatively large area, when a single primary radiator is used, the power supply to resonance elements away from the central axis of the primary radiator is reduced. That is, out of the plurality of resonance elements provided in the resonance element array 200, the middle primary radiator 1b takes charge of the resonance elements provided in the middle portion, substantially one third ~~in the middle~~of the resonance element array 200, the primary radiator 1a takes charge of substantially one third in the upper portion in the drawing, and, in the same way, the primary radiator 1c takes charge of substantially one third in the lower portion in the drawing. In this way, a more uniform power is radiated to all the resonance elements.

Next, the structure of an antenna device according to a fourth embodiment is shown in Fig. 7. Here, reference numeral 6 represents an opening hollow resonator having an opening in the direction of the lens 3. An excitation element 7 is disposed inside the resonator 6. The same resonance element array 200 as shown in Fig. 2 is disposed in the opening portion of the opening hollow resonator 6. This opening hollow resonator 6 resonates in the TE10 mode and is disposed such that its polarization plane is parallel to the length direction (direction of the extension of linear conductors) of the resonance elements provided in the resonance element array 200. Therefore, an electromagnetic field is given to each resonance element in the resonance element array 200 in the opening

surface of the opening hollow resonator 6 by excitation of the excitation element 7. At this time, in the same way as in the cases of the first and second embodiments, the resonance elements in resonance re-radiate an electromagnetic wave as ~~a~~ wave directors. Therefore, in the same way as in the cases of the first and second embodiments, the direction of beams which are collimated by the lens 3 is controlled by switching the position of the resonance devices (elements) operating as a wave director.

Next, the structure of an antenna device according to a fifth embodiment is shown in Fig. 8. Although the lens 3 is used as a collimating means in the first to fourth embodiments, in the example shown in Fig. 8, a reflector 8 is used as a collimating means. That is, the reflector 8 as an offset parabola reflector is disposed at the position where an electromagnetic wave radiated from a fixed resonance elements in the resonance element array 200 is reflected. When the resonance element 201f provided in the resonance element array 200 is excited by an electromagnetic wave from the primary radiator and operates as a wave director, a beams ~~are~~is formed in the direction shown by optical paths 5f. Furthermore, when the resonance element 201d is excited by an electromagnetic wave from the primary radiator and operates as a wave director, ~~beams are~~another beam is formed in the direction shown by optical paths 5d. In this way, the direction of beams can be electronically tilted by controlling a voltage applied by the control portion.

Next, the structure of an antenna device according to a sixth embodiment is shown in Fig. 9. Fig. 9 is a front view of the resonance element array. In this example, a plurality of resonance elements 201 of linear conductors ~~are~~is arranged on the dielectric substrate 203 such that the resonance elements 201 are parallel to each other and are tilted so as to be substantially 45 degrees to the direction of the arrangement. The structure where the reactance circuit 202 is connected to each resonance element 201 is the same as what is shown in Fig. 2.

In this way, an electromagnetic wave of a linearly polarized wave whose plane of polarization is tilted substantially 45 degrees to the horizontal plane is transmitted ~~such that~~as the plurality of resonance elements 201 ~~are~~is arranged so as to be substantially 45 degrees tilted to the arrangement direction of the plurality of resonance elements 201. Therefore, when an antenna device receives transmission radio waves in the direction of the front from the millimeter wave radar ~~are received~~ using an antenna device of the same structure, their plane of polarization and the plane of polarization of the antenna device cross each other at right angles. Therefore, when the antenna device of this structure is applied to millimeter wave radars, the problem of the mutual interference ~~to other devices~~ can be reduced.

Next, the structure of the main portion of an antenna device according to a seventh embodiment is shown in Fig. 10. In Fig. 10, reference numeral 200 represents a resonance element array and the structure is the same as shown in Fig. 2. Reference numeral 1 represents a primary radiator of an electronically controlled wave-director array antenna. That is, a feed element 11 is contained in the center and a plurality of non-feed elements 12a to 12f where a reactance is loaded is disposed around the feed element. The non-feed elements 12a to 12 f are resonance elements where a variable reactance circuit is contained in the middle portion, and an antenna in which the reactance of the variable reactance circuit is loaded is constituted. The structure of the variable reactance circuit is the same as those shown in Figs. 4 and 5. Accordingly, the equivalent electric length changes in accordance with the reactance value and each of the resonance elements ~~are~~is selectively operated as a wave director or reflector.

The feed element 11 operated as a radiator and the radiation pattern variously changes depending on the feed element 11 and the non-feed elements 12a to 12f. Here, the radiation pattern in the direction of the resonance element array 200 is changed. For

example, a control voltage to the variable reactance circuit of the non-feed elements 12a to 12f is controlled so that the center of the radiation pattern may be directed to the ~~direction of~~resonance element~~s~~ which ~~are~~is made to operate as a wave director ~~on~~for the resonance element array 200.

Thus, even if the plurality of resonance elements provided in the resonance element array is widely distributed, an electric power can be uniformly supplied to ~~the~~every resonance element~~s~~ ~~on~~for the resonance element array. Also, an electromagnetic wave radiated from a fixed resonance element~~s~~ can be received by the primary radiator at a uniform sensitivity.

Moreover, in each embodiment shown in the above, a variable reactance circuit in which the reactance is changed by application of a voltage is provided in order to control the resonance frequency of a fixed resonance element~~s~~, but ~~a~~any other control circuit may be provided so that the equivalent electric length of resonance elements may be changed by controlling any other element ~~others except for the change of~~other than the applied voltage.

Please amend the paragraph(s) from page 22, line 4 from the bottom to page 23, line 17 as follows:

In the example shown in Fig. 2, a plurality of resonance elements 201 ~~was~~is formed on a dielectric substrate 203 and a variable reactance circuit 202 ~~was~~is provided substantially in the middle of each resonance element 201, but in the example shown in Fig. 11, each variable resonance circuit~~s~~ 202 ~~are~~is provided at ~~both~~each end~~s~~ of each resonance element 201 and in addition, each auxiliary element~~s~~ 205 ~~are~~is formed each of

the outside of ~~the~~each circuit~~s~~ 202. The other structure is the same as that shown in Fig. 2. The control portion 4 selectively gives a control voltage to the plurality of variable reactance circuits 202 through the control signal line 9. For example, when one resonance element 201 is made completely resonant or substantially resonant at a frequency in use and the other resonance elements are made non-resonant, the resonant or substantially resonant resonance elements operate as a wave director.

Fig. 12 shows a concrete example for the variable reactance circuit 202 shown in Fig. 11. In this example, the variable reactance circuit 202 is composed of a capacitor C and a switching circuit 204 connected in parallel to the capacitor C. The switching circuit 204 is an MEMS element which is turned on and off by application of a control voltage through the control signal line 9.

Please amend the paragraph(s) from page 24, line 1 to line 7 as follows:

Fig. 13 is a front view of a resonance element array 200 constituting the main portion of an antenna device according to a ninth embodiment. In the resonance element array 200, each element ~~antennas made up of~~includes a resonance element 201, ~~resonance~~two reactance circuits 202 and two auxiliary elements 205 ~~are~~is arranged on the dielectric substrate 203 so as to be parallel to each other and substantially 45 degrees tilted to the arrangement direction of the antenna elements.

Please amend the paragraph(s) from page 26, line 10 to line 20 as follows:

The mixer 36 mixes the local signal Lo from the coupler 33 and the reception signal from the circulator 34 to output an intermediate-frequency signal. An IF amplifier circuit 37 amplifies the intermediate-frequency signal at a fixed amplification degree in accordance with the distance. An AD converter 38 converts the voltage signal into a sampling data sequence. In a DC elimination portion 39, out of sampling data sequences obtained by the AD converter 38, an average value of the sampling data sequence ~~of~~ that is obtained during a fixed sampling interval and is~~constituting~~ an object to be processed at a backstage ~~FET~~FFT ~~out of sampling data sequences obtained by the AD converter 38~~ is ~~determined as~~deemed to be a DC component, and the DC component is subtracted from each data of the whole sampling intervals.

Please amend the paragraph(s) from page 27, line 4 from the bottom to page 28, line 3 as follows:

As described above, in an antenna device according to the present invention, the beam scanning is speeded, power consumption for the beam scanning is reduced, operation noise in the beam scanning is eliminated and the reliability can be increased. Furthermore, when required, the beam direction can be directed in any direction and the beam radiation pattern can be changed. Accordingly, an antenna device of the present invention is valuable for radio devices and mobile radars.